

# THE MYSTERIOUS UNIVERSE

A cosmic scene featuring a bright blue starburst in the center, a planet with a red spot on the left, and an asteroid field on the right.

## CHAPTER 9.2

# Recall The 3 Types of Galaxies



Spiral



Elliptical



Irregular



Spiral Galaxy seen from above  
(Andromeda)





Spiral Galaxy seen from the side



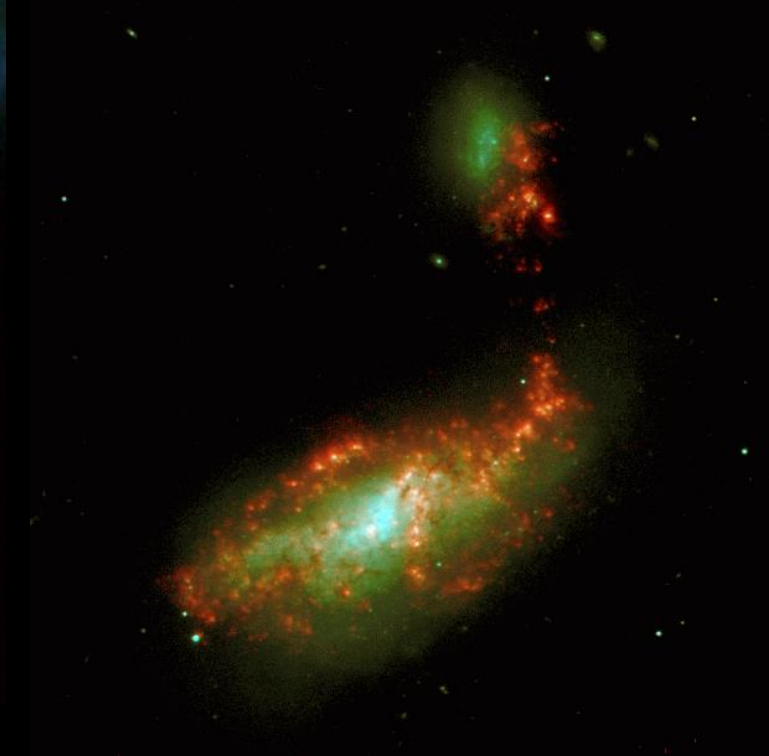
Elliptical Galaxy





Irregular Galaxy - M82





Other irregular galaxies



# LOCAL GROUP (approx. 40 galaxies)

## The Local Group

THE MILKY WAY and Andromeda galaxies rule the Local Group, accounting for more than half its mass. Distances from our galaxy are given in thousands of light-years [kly]



NGC 6822  
1,600 kly

NGC 185  
2,020 kly

NGC 147  
2,365 kly

Pinwheel Galaxy [M33]  
2,850 kly

Andromeda Galaxy [M31]  
2,650 kly



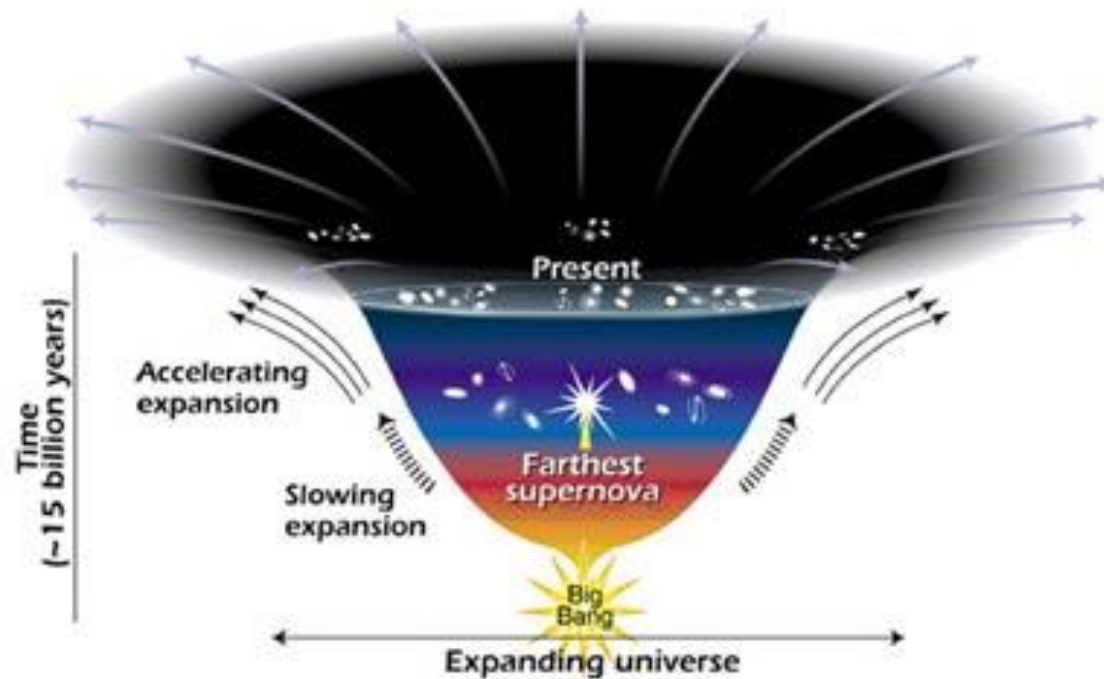
# The universe is expanding

- ▶ **Cosmologists** theorize that there was nothing before the universe; time and space both began 14 billion years ago with the “BIG BANG”.

\*\* It is only a theory and cosmologists continue to evaluate this information

...HOW? What evidence?



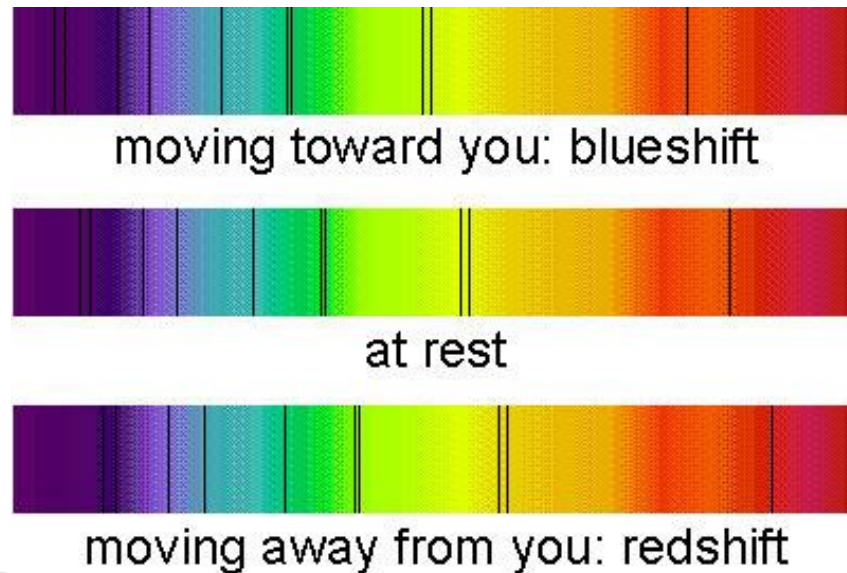


- ▶ This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago.
- ▶ The more shallow the curve, the faster the rate of expansion.
- ▶ The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate.
- ▶ Astronomers theorize that the faster expansion rate is due to a mysterious, **dark force** that is pulling galaxies apart.

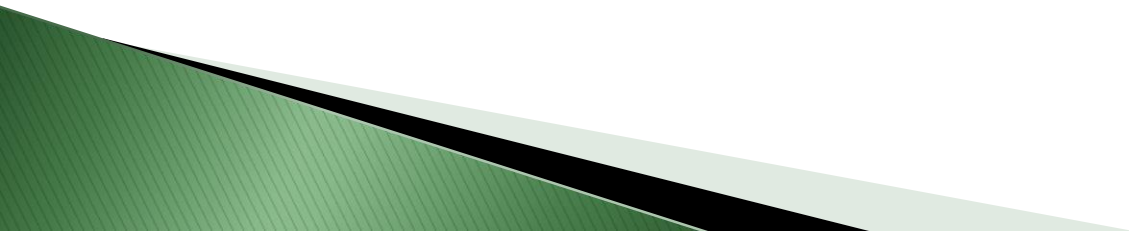


# 1. The Doppler Effect

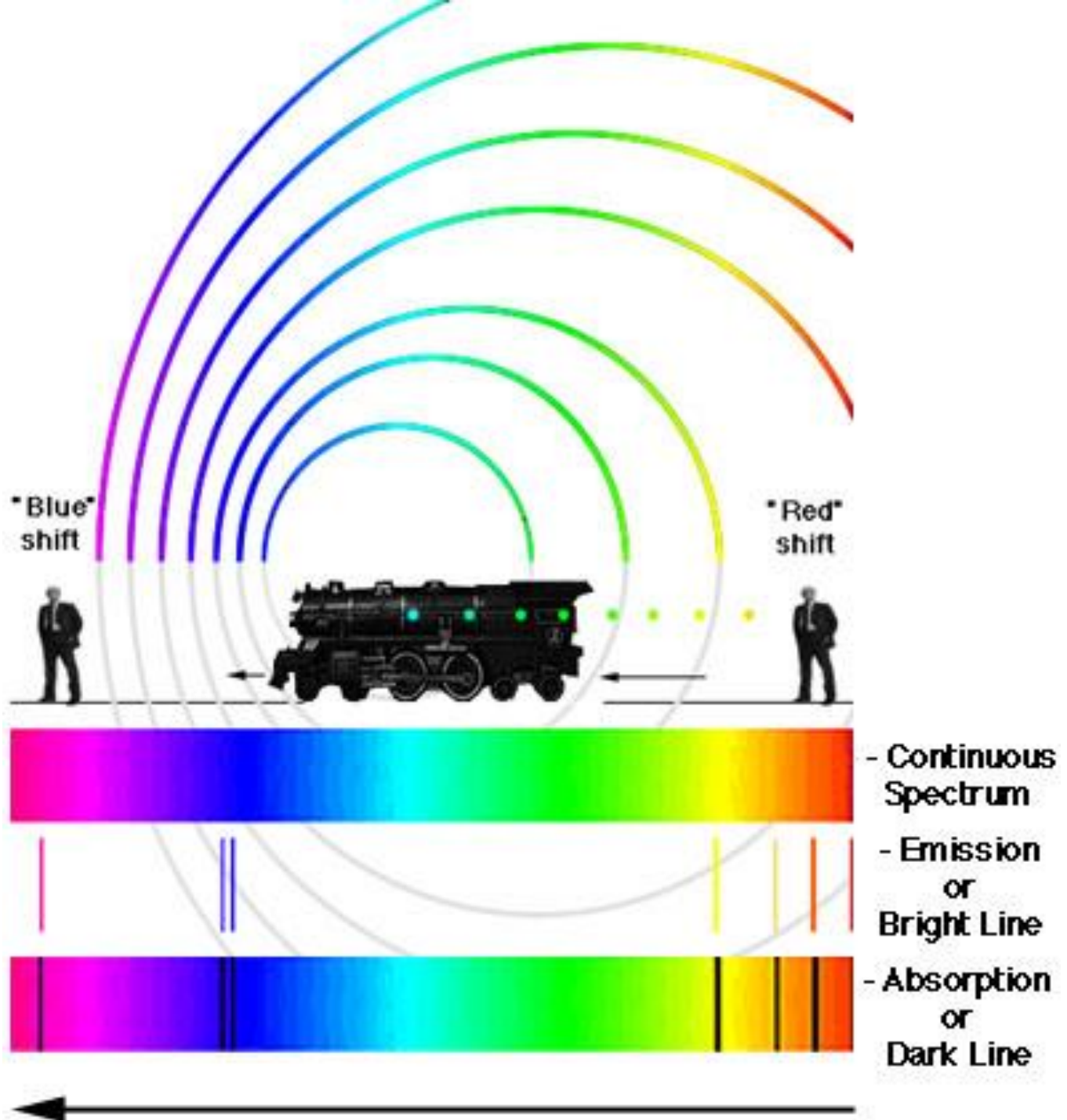
- ▶ Hubble studied the spectra of distant galaxies.
- ▶ Noticed that the spectra were shifted more towards the red side of the spectrum.
- ▶ This is called red shift.
- ▶ What does this mean?



- ▶ The red shift appearance of almost all galaxies tells us these galaxies are moving away from us, in other words, it means the universe is expanding.
- ▶ This evidence is based on the Doppler Effect which explains why we hear sirens differently when a police car is driving away from us.





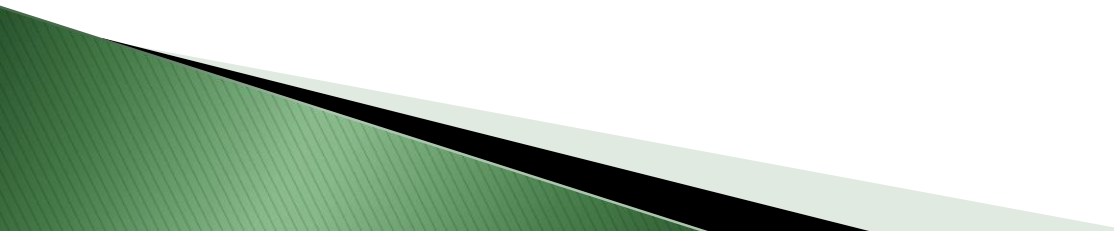


## VIDEO of DOPPLER EFFECT:

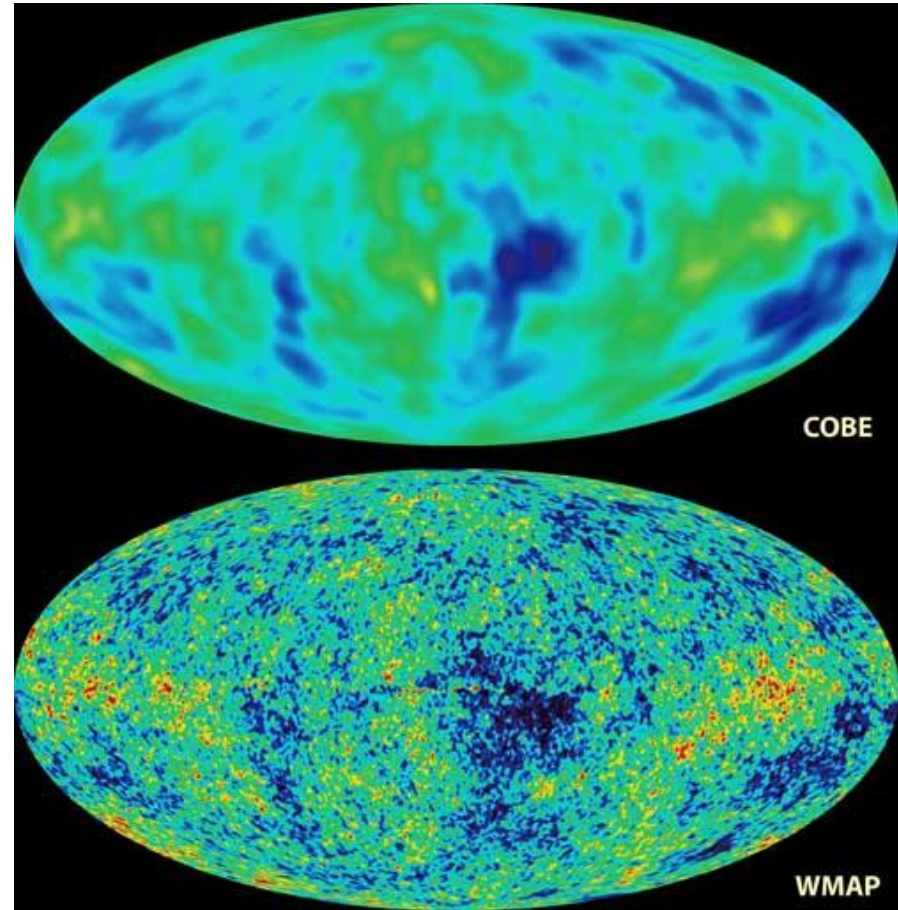
- ▶ Hubble's Law states that the speed of travel of a galaxy is proportional to the distance the galaxy is from Earth: the further away, the faster the speed of travel.



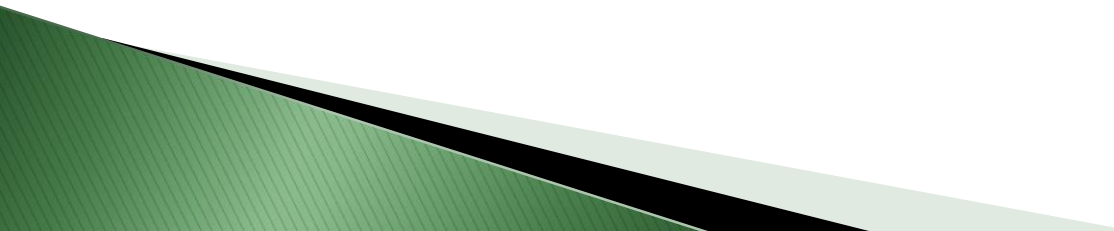
## 2. Cosmic Microwave Background (CMB) Radiation

- This is what is left of the initial energy released by the Big Bang
  - It started off as gamma rays and was stretched by the expansion of the universe until it was much longer microwave radiation
  - Discovered by accident by two Bell Telephone Lab scientists looking for 'noise' that would interfere with satellite communications.
  - [Video](#)
- 

- ▶ Remember, when collecting radiation (like light) we are seeing **back in time**! The light from a star 8 billion light years away shows us the star when it was 8 billion years old! (what would that star see of Earth?)
- ▶ COBE and WMAP satellites measured CMB radiation to create these images (p. 285). They show the universe when it was just 380 000 years old!



# What is happening now?

- ▶ Originally scientists thought that the expansion of the universe would gradually slow down
  - ▶ We now know that the expansion is speeding up!
  - ▶ Due to a mysterious force called dark energy (makes up  $\sim 73\%$  of the universe)
    - The rate of expansion is increasing
  - ▶ Gravity will hold each galaxy together but galaxies will drift apart
  - ▶ The universe will get colder and darker...
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## Assigned work:

- ▶ Read P. 280 to 286
- ▶ p.284 # 2 and 4
- ▶ P.288 # 2, 6, and 7